INTRODUCTION TO ELECTRONIC DEVICES AND CIRCUITS
(ECE 1001)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Barkhausen criterion is associated with the
(a) negative feedback (b) positive feedback
(c) both of them (d) none of them.

(ii) If the differential voltage gain and the common mode voltage gain of a differential amplifier are 48 dB and 2 dB respectively, then its common mode rejection ratio is
(a) 23 dB (b) 25 dB
(c) 46 dB (d) 50 dB

(iii) Semiconductors have
(a) Zero Temperature Coefficient of Resistance
(b) Positive Temperature Coefficient of Resistance
(c) Negative Temperature Coefficient of Resistance
(d) None of the above.

(iv) The maximum efficiency of full wave rectifier is
(a) 40.6 % (b) 100 %
(c) 81.2 % (d) 85.6 %

(v) An intrinsic semiconductor at absolute zero temperature
(a) has large number of holes
(b) has same number of holes and electrons
(c) acts as metal
(d) acts as an insulator.

(vi) In Enhancement n-channel MOSFET, an induced n type channel can be produced between the source and the drain if
(a) V_{GS}= 0 (b) V_{GS} is positive
(c) V_{GS} is negative (d) None of these

(vii) Reverse saturation current in a p-n diode is mainly due to
(a) minority diffusion current (b) minority drift current
(c) majority diffusion current (d) majority drift current

(viii) The ripple factor of a bridge rectifier is
(a) 0.482 (b) 0.812 (c) 1.11 (d) 1.21

(ix) Positive feedback is used in
(a) Amplifiers (b) Rectifiers
(c) Oscillators (d) Detectors

(x) The effective channel length of a MOSFET in saturation decreases with increase in
(a) gate voltage (b) drain voltage
(c) source voltage (d) body voltage.

Fill in the blanks with the correct word

(xi) A _____ is a two-terminal electronic component that conducts current in only one direction.

(xii) α is the current gain of a transistor in _____ configuration.

(xiii) Zener diode is used as _____.

(xiv) The output impedance of an ideal op-amp is _____.

(xv) JFETs are typically operated in the _____ region for most amplifier applications.

Group - B

2. (a) Distinguish between metal, semiconductor and insulator. *[(CO1)(Analyse/IOCQ)]*
(b) Calculate the resistivity of intrinsic silicon at 300K if it has intrinsic carrier concentration of $n_i = 1.5 \times 1016\ m^{-3}$, electron mobility $\mu_n = 0.13\ m^2/Vs$, hole mobility $\mu_p = 0.05\ m^2/Vs$. *[(CO1)(Evaluate/HOCQ)]*
(c) State the Fermi Dirac Distribution Function and plot the function for absolute zero and higher temperatures. *[(CO1)(Apply/IOCQ)]*

3 + 5 + 4 = 12

3. (a) Draw the circuit diagram of a half wave rectifier with and without capacitor filter. Explain the operation with necessary waveforms. *[(CO3)(Remember/LOCQ)]*
(b) A full-wave rectifier uses a double-diode, the forward resistance of each element being 200 Ω. The rectifier supplies current to a load resistance of 1000 Ω. The primary-to-total secondary turns ratio of the centre-tapped transformer is 1:3. The transformer primary is fed from a supply of 240 V (rms). Find (i) dc load current (ii) direct current in each diode (iii) dc output power (iv) ripple voltage across the load resistance and (v) efficiency of rectification. *[(CO3)(Apply/IOCQ)]*

6 + 6 = 12

Group - C

4. (a) Draw the output characteristics of an npn Bipolar Junction Transistor operating in the Common Base mode. Indicate and explain the various regions of operation. *[(CO4)(Analyse/IOCQ)]*

   (b) What is a load line. Explain the concept of Q-point. *[(CO4)(Remember/LOCQ)]*

   (c) A transistor having $\alpha = 0.9$ and Reverse Saturation Current $I_{CO} = 10$ μA operates in CE configuration. Find the value of β. If the Base Current is 300 μA, find the values of the Emitter and Collector Currents. *[(CO4)(Apply/IOCQ)]*

4 + 4 + 4 = 12

5. (a) What is biasing? *[(CO4)(Remember/LOCQ)]*

   (b) Draw the circuit diagram of self biased n-p-n transistor and explain how bias stability is achieved in this case. *[(CO4)(Analyse/LOCQ)]*

   (c) In the fixed bias circuit of a transistor $V_{cc} = 15$ V, $R_B = 300$ KΩ and $R_L = 2$ KΩ. If $\beta=100$, $I_{CO}=20$ nA and $V_{BE}=0.7$ V, determine Q point and the stability factor with respect to I_{CO}. *[(CO4)(Apply/IOCQ)]*

2 + 5 + 5 = 12

Group - D

6. (a) Draw the Drain and Transfer Characteristics of n-channel JFET. *[(CO5)(Analyse/IOCQ)]*

   (b) Explain how JFET can be used as a Voltage Variable Resistor (VVR). *[(CO5)(Apply/IOCQ)]*

   (c) An n-channel JFET has $I_{DSS} = 12$ mA and pinch-off voltage $V_p = -4$ V. Find the drain current for $V_{GS} = -2$ V. If the transconductance g_{mo} of a JFET with the same I_{DSS} at $V_{GS} = 0$ V is 4 milli mho, find the pinch-off voltage. *[(CO5)(Evaluate/HOCQ)]*

4 + 2 + 6 = 12

7. (a) Draw the structure of n-channel depletion type MOSFET and explain its working principle. *[(CO5)(Analyse/IOCQ)]*

   (b) List the differences between depletion type and enhancement type MOSFET. *[(CO4)(Analyse/IOCQ)]*

   (c) Explain channel length modulation in FET. *[(CO4)(Analyse/IOCQ)]*

(3 + 4) + 3 + 2 = 12

Group - E

8. (a) What is Barkhausen criteria? *[(CO6)(Analyse/IOCQ)]*

   (b) An amplifier has an open loop voltage gain of -100 and feedback ratio of -0.04. Find the (i) voltage gain with negative feedback,
   (ii) amount of feedback in dB,
   (iii) output voltage for an input voltage of 40 mV. *[(CO6)(Evaluate/HOCQ)]*

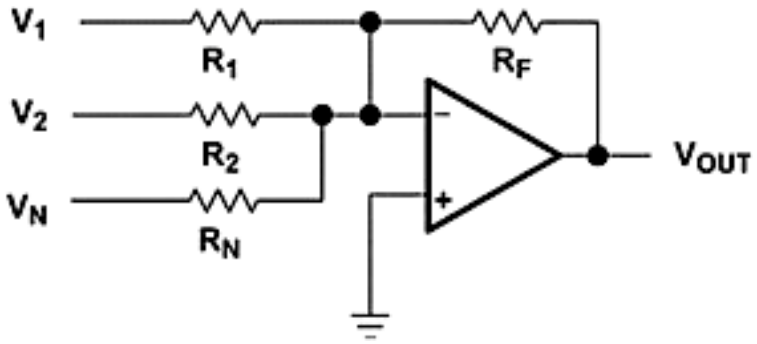
   (c) Briefly describe the various feedback topologies. *[(CO6)(Remember/LOCQ)]*

2 + 6 + 4 = 12

9. (a) What are the characteristics of an ideal OPAMP? *[(CO6)(Remember/LOCQ)]*

(b) Explain the use of OP-AMP as an inverting amplifier. Derive the expression for its voltage gain assuming ideal OPAMP. *[(CO6)(Analyse/IOCQ)]*

(c) Find the output voltage V_0 of the three-input summing amplifier circuit of the following figure where $R_1 = 100\Omega$, $R_2 = 200\Omega$ & $R_3 = 400\Omega$, $R_F = 1\ K\Omega$, $V_1 = -5V$, $V_2 = +2V$ & $V_3 = +4\ V$



[(CO6)(Apply/IOCQ)]

4 + 4 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	26	56.3	17.7

Course Outcome (CO):

After the completion of the course students will be able to

1. Categorize different semiconductor materials based on their energy bands and analyze the change in characteristics of those materials due to different types of doping.
2. Describe energy band of P-N Junction devices and solve problems related to P-N Junction Diode.
3. Design different application specific circuits using diodes.
4. Analyze various biasing configurations of Bipolar Junction Transistor.
5. Categorize different field-effect transistors and analyze their behavior.
6. Design and implement various practical electronic circuits.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*